Tracking the MSL-SAM methane detection source location Through Mars Regional Atmospheric Modeling System (MRAMS)

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The putative in situ detection of methane by SAM instrument has garnered significant attention. There are many major unresolved questions regarding this detection: 1) Where is the release location? 2) How spatially extensive is the release? 3) For how long is CH4 released? In an effort to better address the potential mixing and remaining questions, atmospheric circulation studies of Gale Crater were performed with the Mars Regional Atmospheric Modeling System (MRAMS). The model was focused on rover locations using nested grids with a spacing of 330 meters on the innermost grid that is centered over the landing. MRAMS is ideally suited for this investigation. In order to characterize seasonal mixing changes throughout the Martian year, simulations were conducted at Ls 0, 90, 180 and 270. Two additional simulations at Ls 225 and 315 were explored to better understand the unique meteorological setting centered around Ls 270. Ls 270 was shown to be an anomalous season when air within and outside the crater was well mixed by strong, flushing, northerly flow and large amplitude breaking mountain waves: air flowing downslope at night is cold enough to penetrate all the way to the surface. At other seasons, the air in the crater is more isolated -but not completely- from the surrounding environment: mesoscale simulations indicate that the air flowing down the crater rims does not easily make it to the crater floor. Instead, the air encounters very cold and stable air pooled in the bottom of the crater, which forces the air to glide right over the colder, more dense air below. Thus, the mixing of near surface crater air with the external environment is potentially more limited at seasons other than around Ls 270. The rise in CH4 concentration was reported to start around sol 300 (~Ls 336), peaked shortly after sol 520 (~Ls 82), and then dropped to background values prior to sol 575 (~Ls 103). Two scenarios are considered in the context of the circulations predicted by MRAMS. The first scenario is the release of methane from somewhere outside the crater. The second is a release of methane within the crater. In both cases, the release is assumed to take place near the season when the rise of concentration was first noted (~Ls 336). This is a transitional time at Gale Crater, when the flushing winds are giving way to the more isolated crater scenario. Some preliminary work, including tracer gases into the model, is being performed to establish the amount of mixing during the limited mixing epochs. Preliminary results may support the idea that during periods of limited mixing, there could be enough time for methane to bind to activated mineral surfaces through wind erosion.

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